

# Chemicals Manufacturing, Except Drugs

(SIC 28, except 283)

## SIGNIFICANT POINTS

- Employment is projected to decline.
- Production and installation, maintenance, and repair workers hold almost 50 percent of all jobs.
- Persons with technical and advanced degrees will have the best opportunities, particularly for research and development work.
- Production workers earn more than in most industries.

### Nature of the Industry

Chemicals are an essential component of manufacturing, vital to industries such as construction, motor vehicles, paper, electronics, transportation, agriculture, and pharmaceuticals. Although some chemical manufacturers produce and sell consumer products such as soap, bleach, and cosmetics, most chemical products are used as intermediate products for other goods.

Chemical manufacturing is divided into eight segments, seven of which are covered here: Plastics materials and synthetics; cleaning preparations; organic chemicals; inorganic chemicals; miscellaneous chemicals; paints and allied products; and agricultural chemicals. The eighth segment, drug manufacturing, is covered in a separate *Career Guide* statement.

The largest employer of the segments included here is the plastics materials and synthetics industry, which produces a wide variety of finished products as well as raw materials. Some of these include polyethylene, polypropylene, polyvinyl chloride (PVC), and polystyrene, which can be made into products such as loudspeakers, toys, PVC pipes, and beverage bottles. Motor vehicle manufacturers are particularly large users of these products.

The cleaning preparations portion of the industry is the only one in which much of the production is geared directly toward consumers. This segment includes firms making soaps, detergents, and cleaning preparations. Cosmetics and toiletries also are included in this segment. Households and businesses use these products in many ways, cleaning everything from babies to bridges.

The industrial organic chemicals segment produces chemicals that contain carbon and hydrogen and are made primarily from petroleum and natural gas, often referred to as petrochemicals. Although organic chemicals are used to make a wide range of products, such as dyes, plastics, and pharmaceutical products, the majority of these chemicals are used in the production of other chemicals.

Industrial inorganic chemicals usually are made from salts, metal compounds, other minerals, and the atmosphere. In addition to solid and liquid chemicals, firms in this segment also produce industrial gases such as oxygen, nitrogen, and helium. Many inorganic chemicals serve as processing ingredients in the manufacture of chemicals, but do not appear in the final products because they are used as reaction aids. Other chemical companies are the largest single customer of this segment.

The miscellaneous chemical products segment includes manufacturers of adhesives and sealants, explosives, printing ink, carbon black, and other miscellaneous chemicals. These products are used by consumers or in the manufacture of other products.

The paints and allied products segment includes firms making paints, varnishes, lacquers, putties, paint removers, sealers, and stains. The construction and furniture industries are large customers of this segment. Other customers range from individuals refurbishing their homes to businesses that need anti-corrosive paints that can withstand high temperatures.

Finally, the segment employing the fewest workers in the chemical industry is agricultural chemicals—which supplies farmers and home gardeners with fertilizers, herbicides, pesticides, and other agricultural chemicals.

Chemicals generally are classified into two groups—commodity chemicals and specialty chemicals. Commodity chemical manufacturers produce large quantities of basic and relatively inexpensive compounds in large plants, often built specifically to make one chemical. Most of these basic chemicals are used to make more highly refined chemicals used in the production of everyday consumer goods by other industries. Specialty chemical manufacturers, on the other hand, produce smaller quantities of more expensive chemicals that are used less frequently. Specialty chemical manufacturers often supply larger chemical companies on a contract basis. Many traditional commodity chemical manufacturers are divided into two separate entities, one focused on commodities and the other on specialty chemicals.

**Table 1. Distribution of wage and salary employment in chemicals manufacturing, except drugs by detailed industry, 2000**

Industry	Employment	Percent
Total, all industries .....	723,000	100.0
Soap, cleaners, and toilet goods .....	155,000	14.9
Plastics materials and synthetics .....	154,000	14.8
Industrial organic chemicals .....	120,000	11.5
Industrial inorganic chemicals .....	98,000	9.4
Miscellaneous chemical products .....	93,000	9.0
Paints and allied products .....	52,000	5.0
Agricultural chemicals .....	51,000	4.9

The diversity of products produced by the chemical industry also is reflected in its component establishments. For example, firms producing plastics materials operated relatively large plants in 1997. This segment had 8 percent of the reporting establishments, yet employed almost 21 percent of those working in the chemical manufacturing industry. On the other hand, manufacturers of paints and allied products had a greater number of establishments, each employing a much smaller number

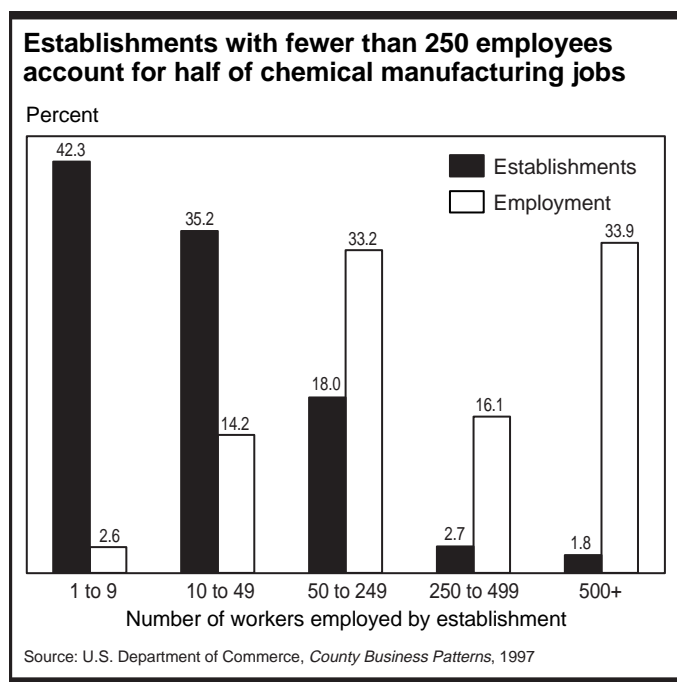
of workers. This segment comprised more than 14 percent of the establishments in the chemical industry, yet employed only 8 percent of all workers. The average workplace in the chemical industry ranged from 138 workers in the plastics materials segment to 35 workers in the soaps and cosmetics segment (chart).

The chemical industry segments vary in the degree to which their workers are involved in production activities, administration and management, or research and development. Industries that make products such as cosmetics or paint that are ready for sale to the final consumer employ more administrative and marketing personnel. Industries that market their products mostly to industrial customers generally employ a greater proportion of precision production workers and a lower proportion of unskilled labor.

Chemical firms are concentrated in areas abundant with other manufacturing businesses, such as in the Great Lakes region near the automotive industry, or on the West Coast near the electronics industry. Chemical plants also are located near the petroleum and natural gas production centers along the Gulf Coast in Texas and Louisiana. Because chemical production processes often use water, and chemicals are primarily exported by ship all over the world, major industrial ports are another common location of chemical plants. California, Illinois, New Jersey, New York, Ohio, Pennsylvania, South Carolina, Tennessee, and Texas had about 50 percent of the establishments in the industry.

### Working Conditions

Manufacturing chemicals usually is a continuous process; this means that, once a process has begun, it cannot be stopped when it is time for workers to go home. Split, weekend, and night shifts are common, and workers on such schedules usually are compensated with higher rates of pay. As a result, the average workweek in the chemical industry was 43 hours in 2000, over 2 hours longer than the average for nondurable manufacturing industries, and over 8 hours longer than the average for all private industries. The industry employs relatively few part-time workers.



The plants usually are clean, although the continually running machines sometimes are loud and the interior of many plants can be hot. Hardhats and safety goggles are mandatory and worn throughout the plant.

Hazards in the chemical industry can be substantial, but they generally are avoided through strict safety procedures. Workers require protective gear and extensive knowledge of the dangers associated with the chemicals being handled. Body suits with breathing devices designed to filter out any harmful fumes are mandatory for work in dangerous environments.

In spite of the hazards of working with chemicals, extensive worker training on handling hazardous chemicals and chemical company safety measures have resulted in injury and illness rates for some segments of the chemical industry that are much lower than the average for the manufacturing sector. The chemical industry reported just 4.4 cases of work-related injury or illness per 100 workers, compared with an average of 9.2 cases for all manufacturing industries in 1999.

### Employment

The chemical and allied products industry employed about 723,000 wage and salary workers in 2000, about 4 percent of the total number employed in manufacturing and almost 10 percent of the total number employed in nondurable goods manufacturing. Most segments of the industry had substantial numbers of jobs, as shown in table 1.

### Occupations in the Industry

Nearly three-fifths of those employed in the industry work in production; installation, maintenance, and repair; and transportation and material-moving occupations. More than one-fifth work in management, business, and financial; and office and administrative support occupations. About 14 percent work in professional and related occupations (table 2).

**Production.** Workers in production occupations operate and fix plant machinery, transport raw materials, and monitor the production process. Improvements in technology gradually are increasing the level of plant automation, reducing the number of jobs in production occupations. Although high school graduates qualify for most entry-level production jobs, advancement into better-paying jobs, requiring higher skills or more responsibility, is possible with on-the-job training and work experience or through additional vocational training at a 2-year technical college.

*Chemical plant and system operators* monitor the entire production process. From chemical ingredient ratios to chemical reaction rates, the operator is responsible for the efficient operation of the chemical plant. Chemical plant operators generally advance to these positions from among the most experienced production workers, usually after having acquired extensive experience and technical training in chemical production processes. Experienced operators sometimes advance to senior supervisory positions.

*Industrial machinery mechanics* and *machinery maintenance workers* repair equipment, install machines, or practice preventive maintenance in the plant. Workers advance to these jobs either through apprenticeships or formal vocational training, or by completing in-house training courses.

*Inspectors, testers, sorters, samplers, and weighers* assure that the production process runs efficiently and that products are of acceptable quality. They refer problems to plant operators or management.

**Table 2. Employment of wage and salary workers in chemicals manufacturing, except drugs, by occupation, 2000 and projected change, 2000-10**

(Employment in thousands)

Occupation	Employment, 2000		Percent change, 2000-2010
	Number	Percent	
<b>All occupations</b> .....	723	100.0	-4.5
<b>Management, business, and financial occupations</b> .....	77	10.6	-3.3
Marketing and sales managers .....	7	1.0	12.3
General and operations managers .....	12	1.7	-3.6
Industrial production managers .....	10	1.3	-7.4
Business operations specialists .....	14	2.0	-4.2
<b>Professional and related occupations</b> .....	99	13.7	-6.1
Computer specialists .....	9	1.2	19.3
Chemical engineers .....	12	1.6	-11.1
Chemists .....	16	2.2	-3.7
Chemical technicians .....	23	3.1	-7.3
<b>Sales and related occupations</b> .....	24	3.3	-3.7
Sales representatives, wholesale and manufacturing, technical and scientific products .....	8	1.2	-5.2
Sales representatives, wholesale and manufacturing, except technical and scientific products .....	9	1.3	-4.0
<b>Office and administrative support occupations</b> .....	84	11.7	-6.3
Bookkeeping, accounting, and auditing clerks .....	7	1.0	-10.5
Customer service representatives .....	9	1.3	2.0
Shipping, receiving, and traffic clerks .....	12	1.7	-4.1
Executive secretaries and administrative assistants .....	9	1.2	-10.7
<b>Installation, maintenance, and repair occupations</b> .....	56	7.8	-8.2
Industrial machinery mechanics .....	13	1.8	-4.3
Maintenance and repair workers, general .....	20	2.8	-12.9
<b>Production occupations</b> .....	300	41.6	-3.8
First-line supervisors/managers of production and operating workers .....	28	3.8	-10.5
Team assemblers .....	14	1.9	-2.4
Metal workers and plastic workers .....	15	2.1	-11.5
Chemical plant and system operators .....	56	7.8	-6.0
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers .....	15	2.1	-12.7
Textile winding, twisting, and drawing out machine setters, operators, and tenders .....	9	1.2	-13.1
Chemical equipment operators and tenders .....	33	4.6	4.9
Mixing and blending machine setters, operators, and tenders .....	29	4.1	5.4
Helpers—Production workers .....	17	2.4	-4.1
Inspectors, testers, sorters, samplers, and weighers .....	12	1.6	-19.3
Packaging and filling machine operators and tenders .....	28	3.9	8.2
<b>Transportation and material moving occupations</b> .....	65	8.9	-2.0
Truck drivers, heavy and tractor-trailer .....	10	1.4	-3.5
Industrial truck and tractor operators .....	10	1.4	-2.7
Laborers and freight, stock, and material movers, hand .....	14	1.9	-6.7
Packers and packagers, hand .....	12	1.6	6.6

NOTE: May not add to totals due to omission of occupations with small employment.

*Packaging and filling machine operators and tenders* wrap products and fill boxes to prepare the final product for shipment or sale to the wholesaler or consumer. More than half of these jobs are in the soap and cosmetics industry, due to the amount of packaging needed for this industry's consumer products.

*Transportation and material-moving workers* move materials around the plant using industrial trucks or deliver finished products to customers by truck. For these jobs, employers seek experienced workers with knowledge of chemical hazards, safety procedures, and regulations governing the transport of hazardous chemicals. Operation of industrial trucks and tractors can be learned with on-the-job training, but previous experience driving a truck and a commercial driver's license generally are required to operate a tractor-trailer carrying chemicals. Some jobs in transportation and material movement are open to workers without experience. Workers in these jobs move raw materials and finished products through the chemical plant and assist motor vehicle operators in loading and unloading raw materials and chemicals. They learn safe ways to handle chemicals on the job and develop skills that enable them to advance to other occupations.

**Research, development, and technical.** Most workers in research and development have at least a college degree, and many have advanced degrees. Engineers, scientists, and technicians account for a growing portion of industry employment.

*Chemists and materials scientists* carry out research in a wide range of activities, such as analysis of materials, preparation of new materials or modification of existing ones, study of process chemistry pathways for new or existing products, and formulations of cosmetics, household care products, or paints and coatings. They also try to develop new chemicals for specific applications and new applications for existing chemicals. The most senior chemists sometimes advance to management positions. Although chemical companies hire some chemists with bachelor's degrees, a master's or doctoral degree is becoming more important for chemist jobs.

*Chemical engineers* design equipment and develop processes for manufacturing chemicals on a large scale. Chemical research engineers design and conduct experiments to learn how processes behave and conduct research for potential new chemical products and processes. A bachelor's degree is essential for these jobs, and a master's degree may be preferred or required for some jobs.

*Engineering and science technicians* assist chemists and engineers in research activities and may conduct some research independently. Those with bachelor's degrees in chemistry or graduates of 2-year technical institutes usually fill these positions. Some graduates of engineering programs start as technicians until an opportunity to advance into an engineering position arises.

**Administration and management.** Most managers need a 4-year college degree in addition to experience in the industry. As in other highly technical industries, top managerial positions often are held by those with substantial technical experience. Employment in administrative support and managerial occupations is expected to decline as companies merge and consolidate operations.

*Engineering managers* conduct cost estimations, perform plant design feasibility studies, and coordinate daily operations.



These jobs require a college degree in a technical discipline, such as chemistry or chemical engineering, and experience in the industry. Some employees advance from research and development positions to management positions.

*Advertising, marketing, promotions, public relations, and sales managers* promote sales of chemical products by informing customers of company products and services. A bachelor's degree in marketing, chemistry, or chemical engineering usually is required for these jobs.

*Office and administrative support workers* perform office functions such as secretarial duties, bookkeeping, material records processing, and other clerical duties. Training beyond high school and familiarity with computers is preferred for these occupations.

## Training and Advancement

Despite recent reductions in the workforce, the chemical industry offers career opportunities for persons with varying levels of experience and education. Training and advancement differ for the three major categories of occupations.

Production workers may start as laborers or in other unskilled jobs and, with experience and training, advance into better-paying positions that require greater skills or have greater responsibility. Substantial advancement is possible even within a single occupation. For example, chemical plant operators may move up through several levels of responsibility until they reach the highest paying operator job. Advancement in production occupations usually requires mastery of advanced skills. Such skills usually are the result of a combination of on-the-job-training and formal training provided by the employer. Some workers advance into supervisory positions.

Most jobs in research and development require substantial technical education after high school, but opportunities exist for persons with degrees ranging from a 2-year associate degree up to a doctorate. Development of new products and the award of patents bring increases in pay and prestige, but after a point advancement may require moving from research and development into management. Researchers usually are familiar with company objectives and production methods, which, combined with college education, equips them with many of the tools necessary for management positions.

Managerial jobs usually require a 4-year college degree, though some may require only a 2-year technical degree. Managers can usually advance into higher level jobs without additional formal training outside the workplace, although competition is keen. In general, advancement into the highest management ranks depends on experience and proven ability to handle responsibility in several functional areas. Among larger worldwide firms, international experience is important for

career advancement. Also, industry restructuring has left fewer layers of management, increasing competition for promotions.

## Earnings

Earnings in the chemical industry are higher than average. The weekly earnings for all production workers in chemical manufacturing averaged \$768 in 2000, compared with \$597 in all manufacturing industries and \$474 throughout private industry. This was due, in part, to more overtime and weekend work, which commands higher hourly rates.

Wages of workers in the chemical industry vary according to occupation, the specific industry segment, and size of the production plant. Earnings for the largest occupations in selected industries are shown in table 3.

Earnings also vary by industry within the chemical industry. Median weekly earnings for production workers were highest in industrial organic chemicals, \$962, and lowest in soaps, cleaners, toilet goods, \$625.

The principal unions representing chemical workers are the PACE (Paper, Allied-Industrial, Chemical, and Energy Workers) International Union and the International Chemical Workers Union. In 2000, 13.2 percent of chemical manufacturing workers were union members or covered by union contracts, compared with 15 percent of all workers.

## Outlook

Although the chemical industry's output is expected to grow, employment in the chemical and allied products industry, excluding drugs, is projected to decline by about 4 percent over the 2000-10 period, compared with 15 percent growth expected for the entire economy. The expected decline in chemical manufacturing employment can be attributed to trends affecting the U.S. and global economies. There are several factors that will influence chemical industry employment, such as more efficient production processes and increased plant automation, the state of the national and world economy, company mergers and consolidation, increased foreign competition, outsourcing of production, growth of environmental health and safety concerns and legislation, precision farming techniques, and an emphasis on specialty chemicals.

Improvements in production technology have reduced the need for workers in production; installation, maintenance, and repair; and material-moving occupations, which account for a large proportion of jobs in the chemical industry. The growing application of computerized controls in standard production, and the growing manufacture of specialty chemicals requiring precise, computer-controlled production methods, will reduce the need for workers to monitor or directly operate equipment.

**Table 3. Median hourly earnings of the largest occupations in chemicals manufacturing, except drugs, 2000.**

Occupation	Industrial inorganic chemicals	Soap, cleaners, and toilet goods	Agricultural chemicals	All industries
Chemical engineers .....	\$ 29.97	\$ 32.11	\$ 29.76	\$ 31.71
First-line supervisors/managers of production and operating workers .....	24.24	20.82	22.32	19.39
Chemists .....	23.88	24.26	25.38	24.07
Chemical plant and system operators .....	19.80	16.88	18.38	19.59
Industrial machinery mechanics .....	19.63	18.11	18.97	17.30
Maintenance and repair workers, general .....	19.16	18.08	17.87	13.39
Chemical equipment operators and tenders .....	18.20	16.44	17.62	17.21
Chemical technicians .....	17.84	16.53	18.86	17.05
Packers and packagers, hand .....	17.74	8.10	8.49	7.53
Mixing and blending machine setters, operators, and tenders .....	13.91	12.79	10.84	12.58

Although production facilities will be easier to run with the increased use of computers, the new production methods will require workers with a better understanding of the use of the systems.

Foreign competition has been intensifying in most industries, and the chemical industry is no exception. Although the U.S. chemical industry has enjoyed a favorable trade balance for quite some time, growing global trade and rapidly expanding foreign production capabilities should increase competition. Pressure to reduce costs and streamline production will result in the continuing mergers and consolidation of companies both within the United States and abroad. Mergers and consolidations are allowing chemical companies to increase profits by eliminating duplicate departments and shifting operations to locations in which costs are lowest. U.S. companies are expected to move some production activities to developing countries—those in East Asia and Latin America, for example—to take advantage of rapidly expanding markets.

To satisfy growing public environmental concerns and to comply with the many government regulations, the chemical industry invests billions of dollars yearly in technology to reduce pollution and clean up existing waste sites. Growing concerns about chemicals and the environment will spur producers to create chemicals with fewer, less dangerous, or useable by-products that can be recycled or disposed of cleanly. This will require greater investment in research and development. As a result, occupations related to environmental compliance, improving product visibility, and promoting consumer confidence should grow.

Precision farming techniques have reduced the demand for agricultural chemicals in this country as farmers use computer technology to determine which chemicals need to be applied in different areas of the farm, rather than simply fertilizing the whole farm. However, this reduced demand will be partially offset by the increase in global demand for agricultural chemicals as other countries become more sophisticated in their farming techniques.

Another trend in the chemical industry is the rising demand for specialty chemicals. Chemical companies are finding that, in order to remain competitive, they must differentiate their products and produce specialty chemicals, such as advanced polymers and plastics designed for customer-specific uses—for example, a durable body panel on an automobile. Because advanced processes often are needed to produce specialty chemicals, this trend should increase employment opportunities for highly trained research and development and production-oriented chemists, chemical engineers, technicians, and production personnel. In these small- to medium-size firms,

responsiveness to customers' chemical needs is imperative, so opportunities for marketing staff such as sales engineers also should be available. An emerging technology within specialty chemicals that will require more research and development is the modeling of chemical reactors and batch and continuous processes.

The factors affecting employment in the chemical manufacturing industry will impact different segments of the industry to varying degrees. The two segments projected to add the most jobs are agricultural chemicals, with an increase of about 4,500 jobs; and paints and allied products, with an increase of around 4,000 jobs. The two largest losers of jobs are plastics materials and synthetics, with about 24,000 fewer jobs projected, and industrial inorganic chemicals, with a projected loss of about 16,000 jobs.

In terms of specific occupations, employment opportunities in the chemical industry can be divided into production and nonproduction occupations. Jobs in production are expected to decline as the increasing automation of the chemical industry improves efficiency and as some production activities are moved overseas, but the outlook is somewhat brighter for certain professional occupations, such as computer specialists. Marketing and sales occupations will decline due to the elimination of personnel as a result of company restructuring and mergers. In general, persons with technical and advanced degrees will have the best opportunities in the chemical industry.

### Sources of Additional Information

Additional information on training and careers in the chemical and allied products industry is available from:

- American Chemical Society, 1155 16th St. NW., Washington, DC 20036. Internet: <http://www.acs.org>
- American Institute of Chemical Engineers, 3 Park Ave., New York, NY 10016-5991. Internet: <http://www.aiche.org>

Detailed information on many occupations in the chemical industry, including the following, may be found in the 2002-03 edition of the *Occupational Outlook Handbook*.

- Chemical engineers
- Chemists and materials scientists
- Computer programmers
- Engineering technicians
- Industrial production managers
- Material-moving occupations
- Systems analysts, computer scientists, and database administrators